



Development of Prototype National Water Model Products for Drought Monitoring

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NOAA CPC: Kingtse Mo, Jesse Meng, David DeWitt

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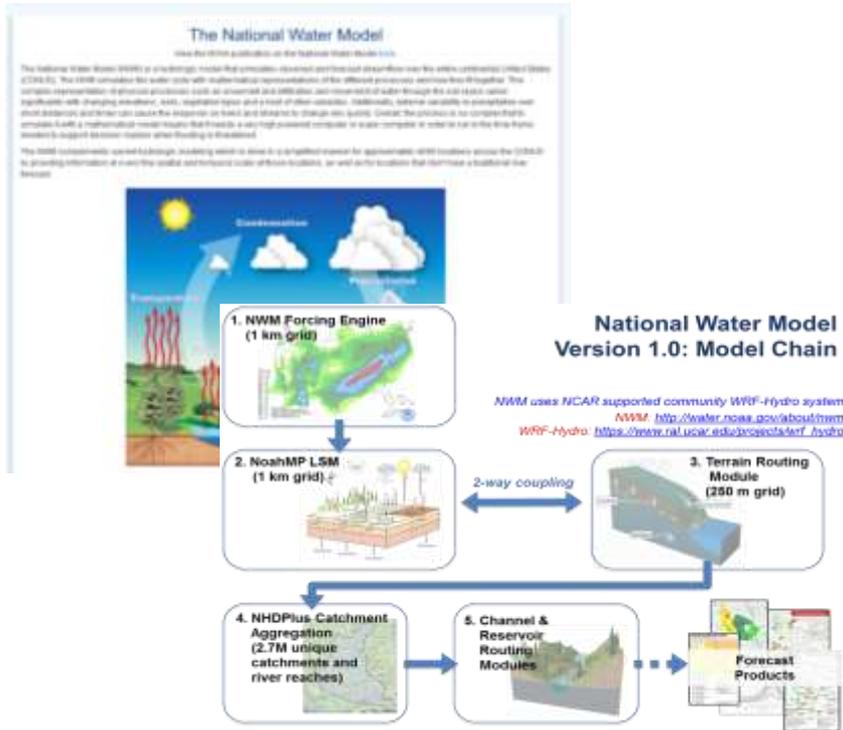
Outline

- Brief overview of the National Water Model (NWM)
- Examples of products under development:
 - Soil moisture (prototype over Russian River, CA)
 - Evaluation
 - Products, including comparison with NLDAS2 Noah soil moisture and USDM
 - Kernel Density Estimates for climatologies
 - Streamflow
 - Evaluation
 - Prototype products

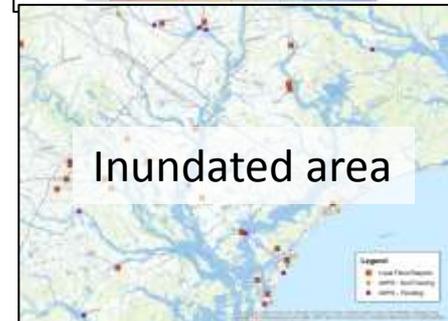
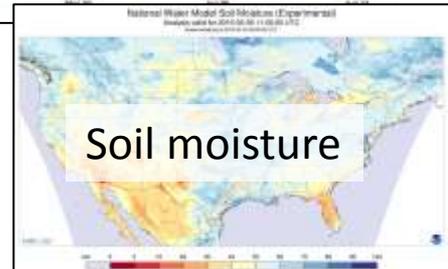
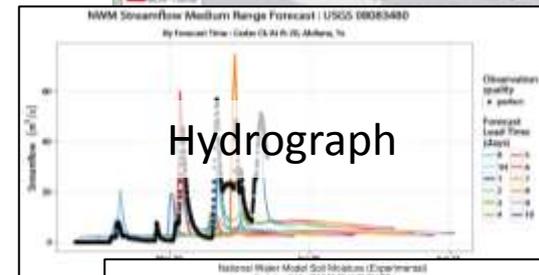
The National Water Model

Development Team: NCAR/RAL, NOAA/OWP/NWC, USGS, CUAHSI, Universities

Sponsor: NOAA Office of Water Prediction



<http://water.noaa.gov/about/nwm>



System become fully operational beginning Aug. 16, 2016

- Real-time verification since June 2016 (Rwrhydro)
- Multiple operational products created by NOAA, academia, private sector

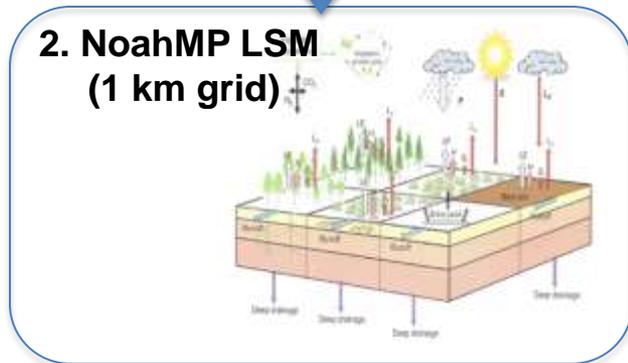
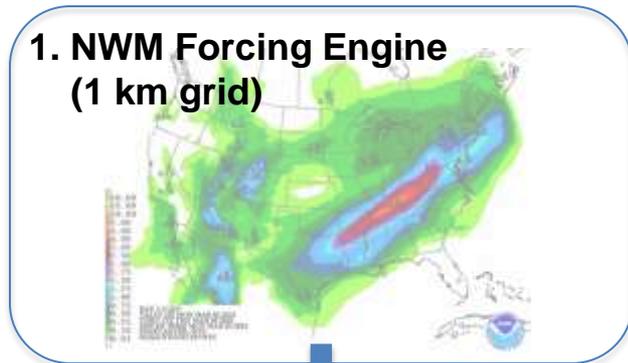
Slide courtesy David Gochis (NCAR)

National Water Model Initial Operating Capability: Model Chain

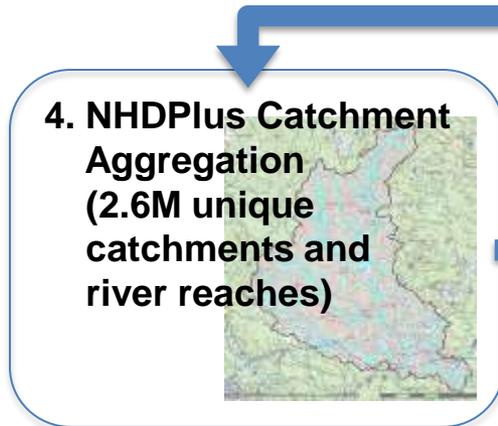
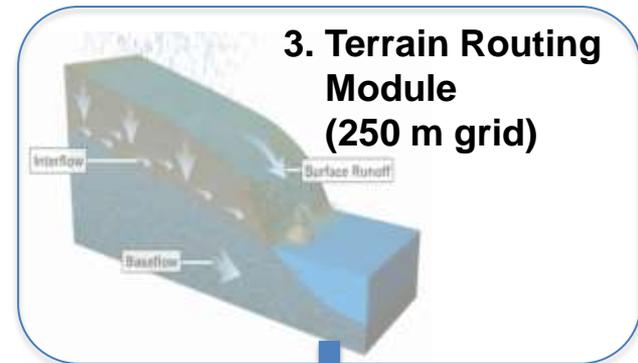
NWM uses NCAR supported community WRF-Hydro system

NWM: <http://water.noaa.gov/about/nwm>

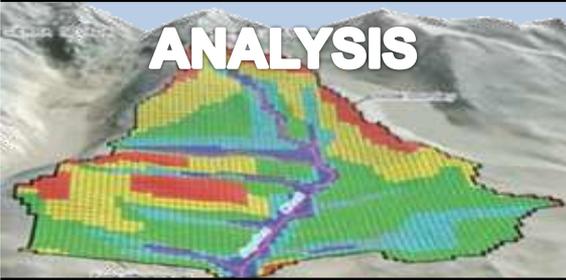
WRF-Hydro: https://www.ral.ucar.edu/projects/wrf_hydro



2-way coupling

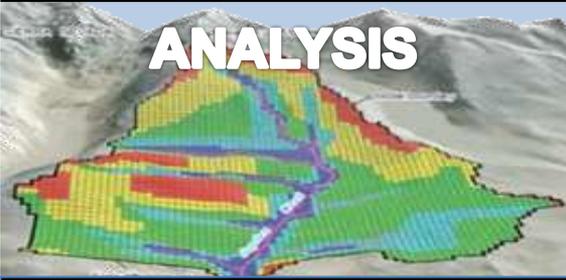


NWM Operational Cycles:

	Cycling	Forecast	Met Forcing	Outputs
 <p>ANALYSIS</p>	Hourly	-3 - 0 hrs	MRMS QPE and HRRR/RAP blend	1-km spatial fluxes (water & energy); 250-m routed fluxes (water); NHDPlus channel routing
 <p>SHORT-RANGE</p>	Hourly	1 – 18 hrs	Downscaled HRRR/RAP Blend	1-km spatial fluxes (water & energy); 250-m routed fluxes (water); NHDPlus channel routing
 <p>MEDIUM-RANGE</p>	4x Daily	to 10 days	Downscaled GFS	1-km spatial fluxes (water & energy); 250-m routed fluxes (water); NHDPlus channel routing
 <p>LONG-RANGE</p>	Daily x 16 ensembles	to 30 days	Downscaled & NLDAS2 Bias- Corrected CFS	1-km spatial fluxes (water & energy); NHDPlus channel routing

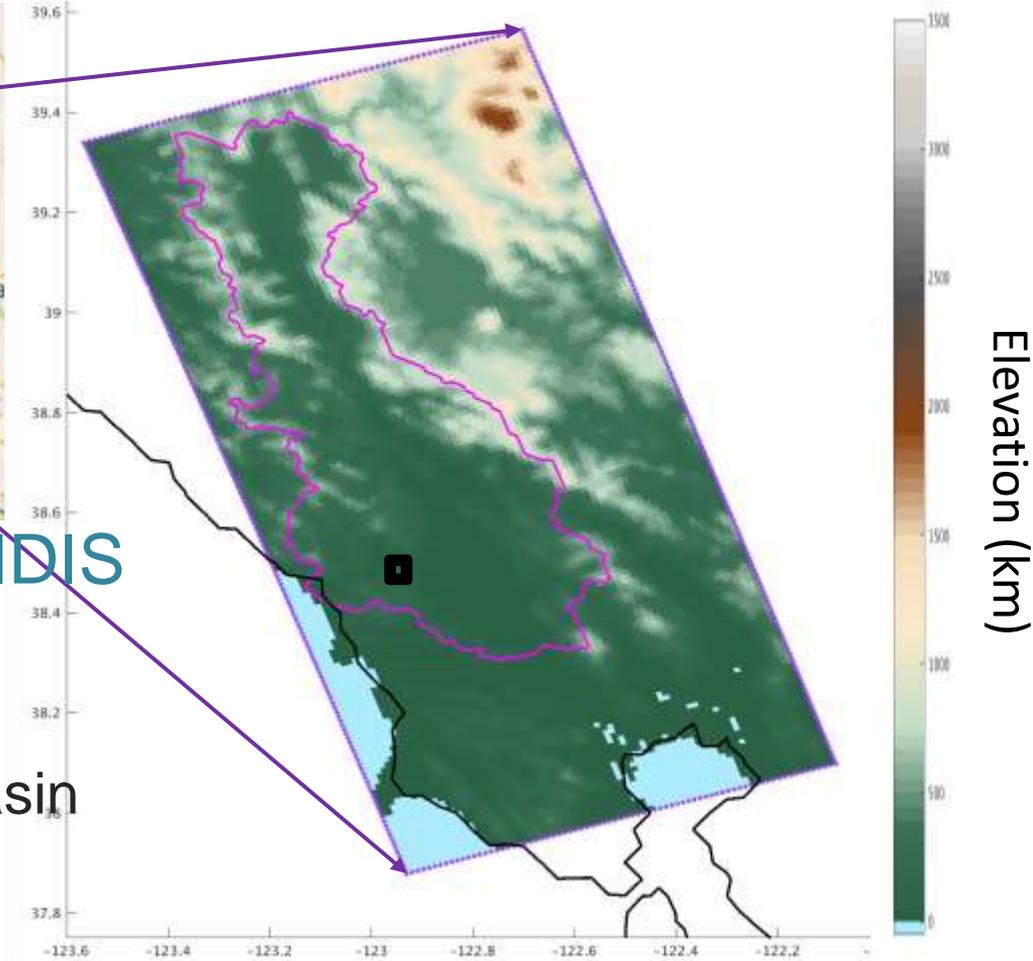
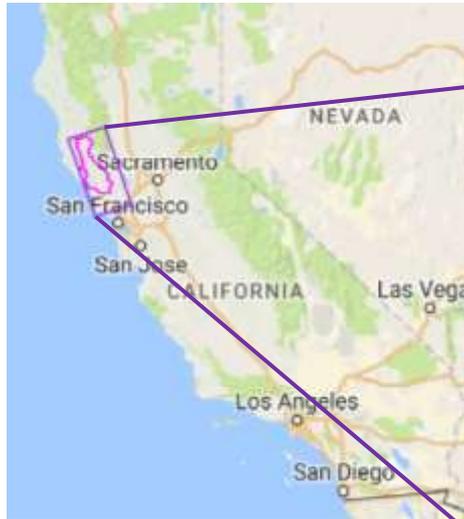
Slide courtesy David Gochis (NCAR)

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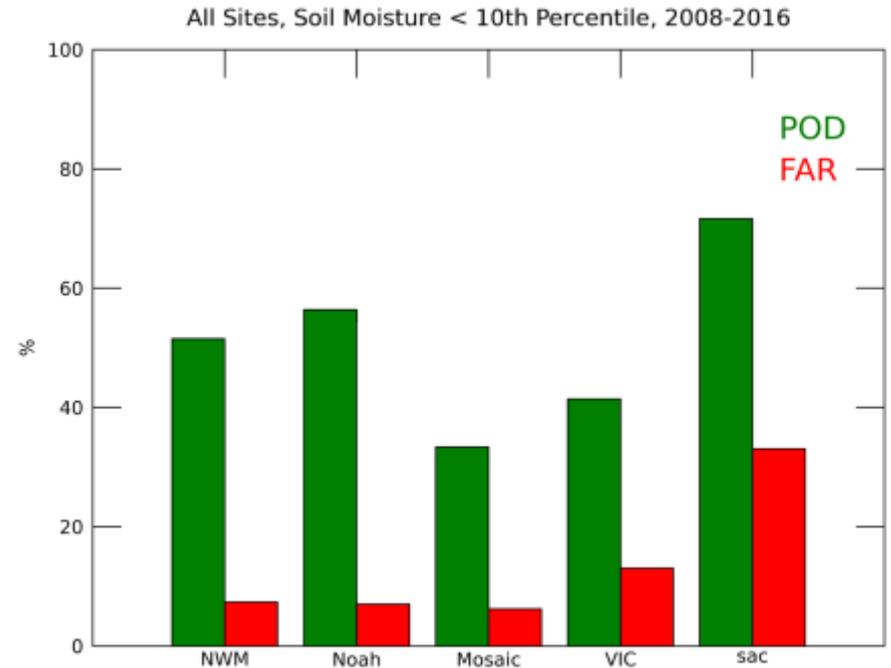
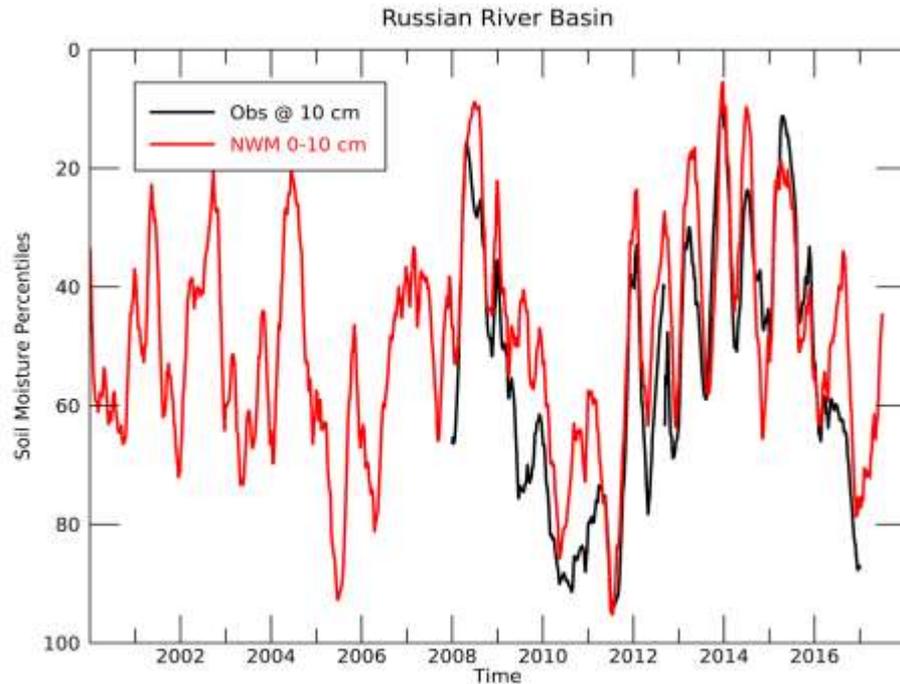
Project goal: Create products from the NWM analysis outputs for drought monitoring purposes.

Demonstration regions (soil moisture)



- Initial focus will be on NIDIS priority watersheds:
 - Russian River Basin
 - Lower Colorado River Basin
 - Missouri River Basin
 - ACF (Apalachicola, Chattahoochee, and Flint) River Basin

Comparison against in situ observations

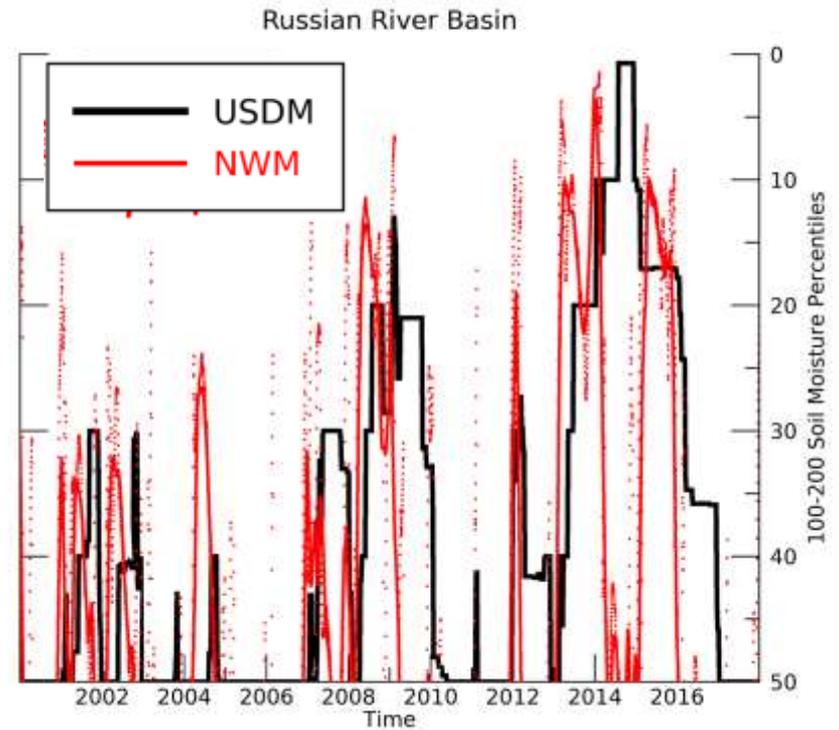
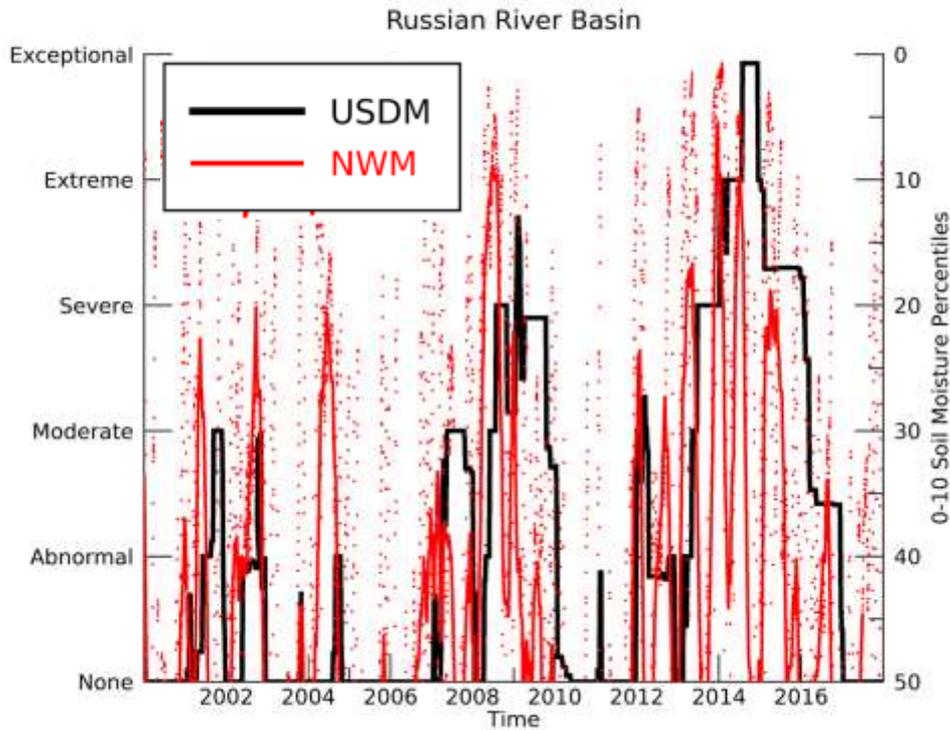


2x2 Contingency Table		Event Observed	
		Yes	No
Event Forecast	Yes	a (hits)	b (false alarms)
	No	c (misses)	d (correct negatives)

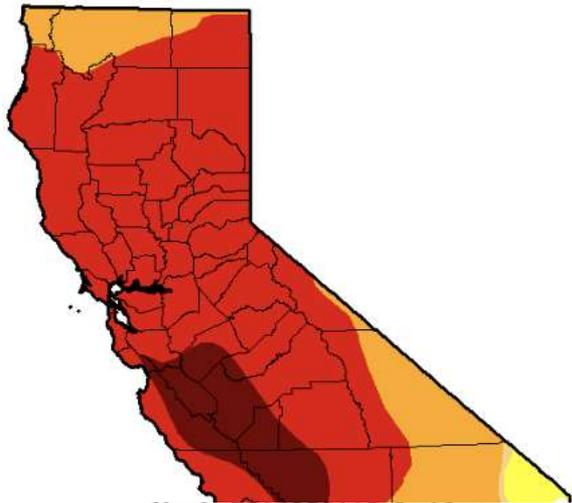
$$\text{POD} = a/(a+c)$$

$$\text{FAR} = b/(a+b)$$

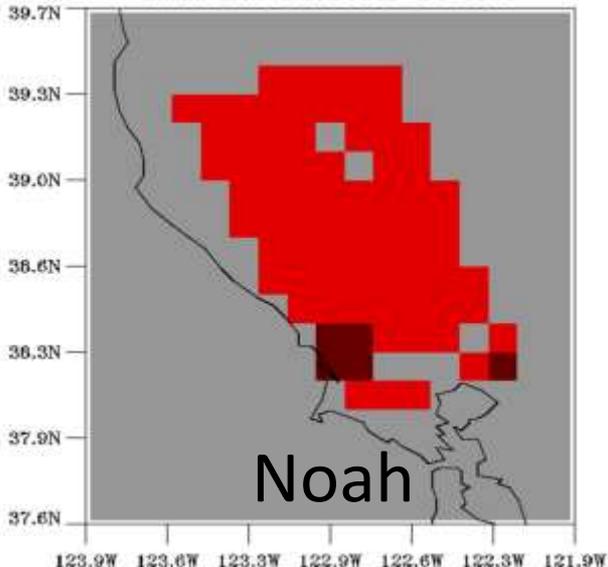
Comparison against USDM



U.S. Drought Monitor California

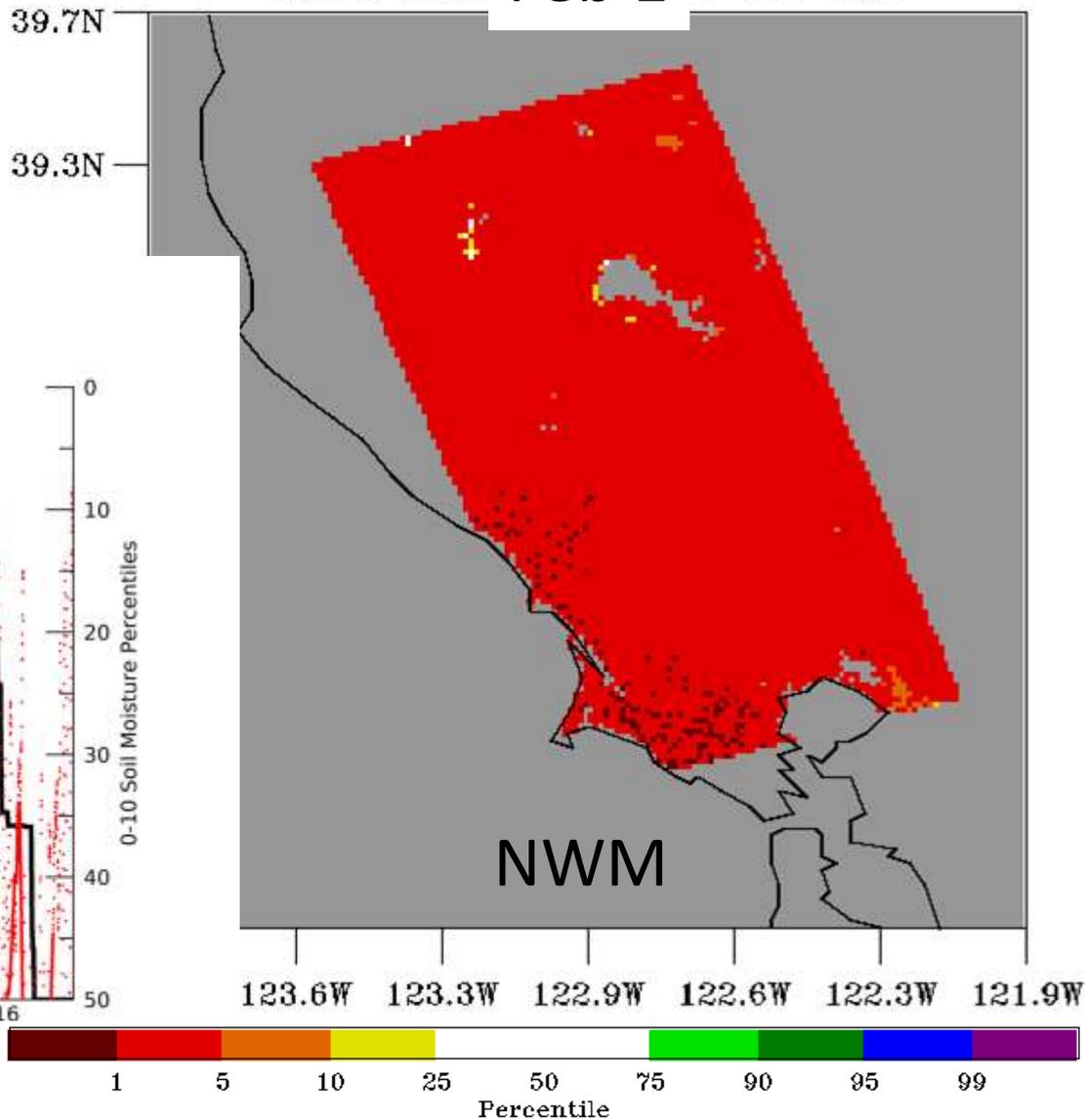


Noah 2014020112 0-10 cm



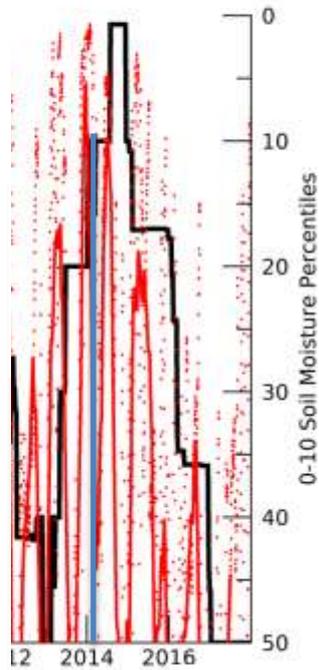
Noah

NWM 2014 Feb 1 0-10 cm

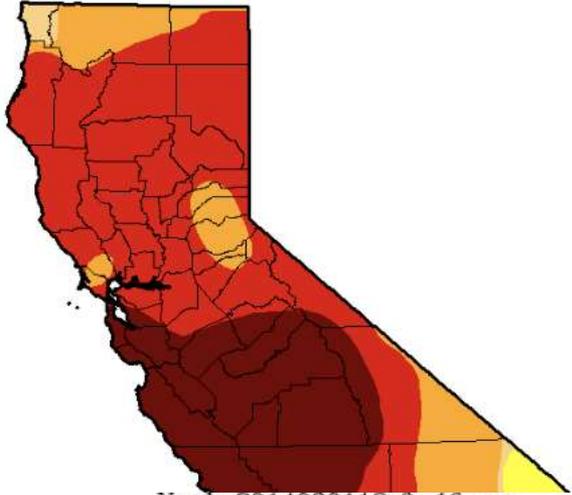


NWM

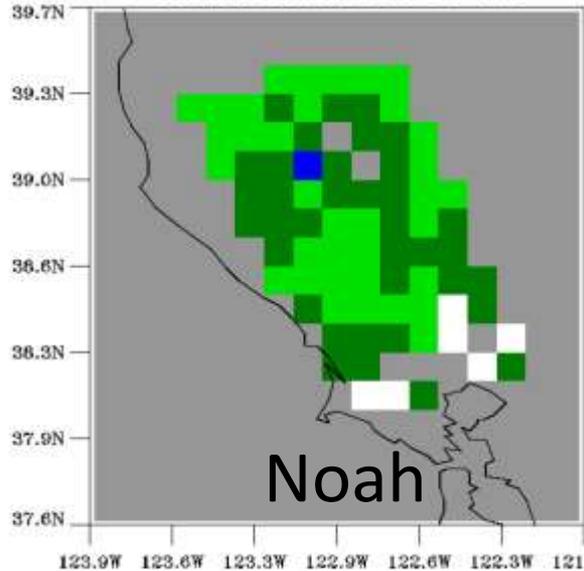
1 5 10 25 50 75 90 95 99
Percentile



U.S. Drought Monitor California

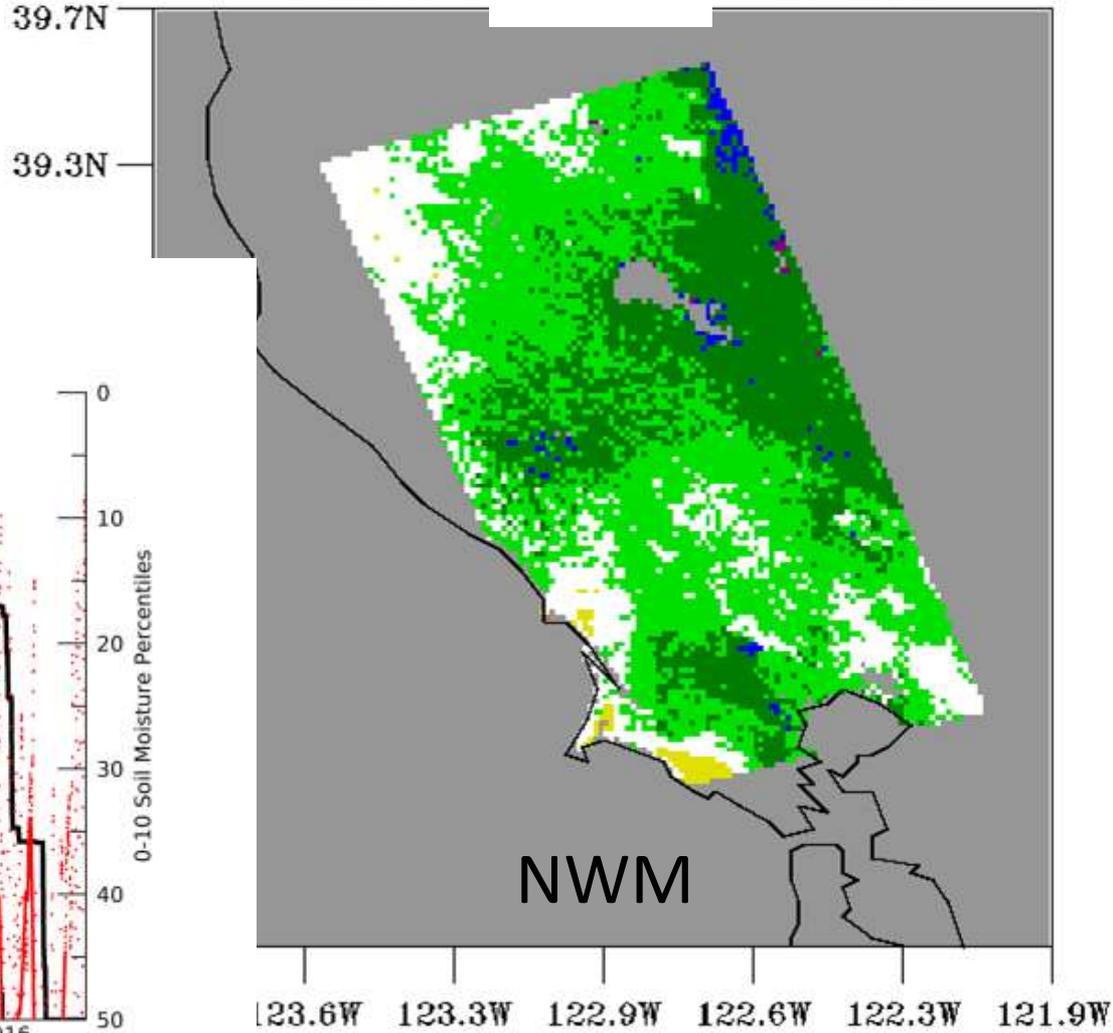


Noah 2014030112 0-10 cm

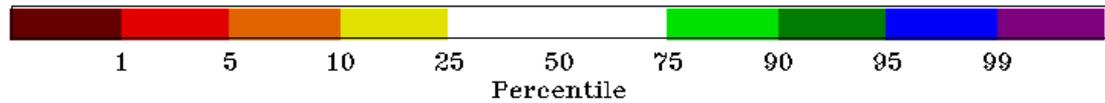
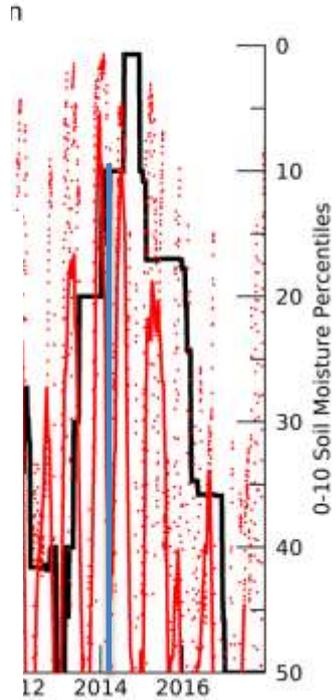


Noah

NWM 201 Mar 1 0-10 cm



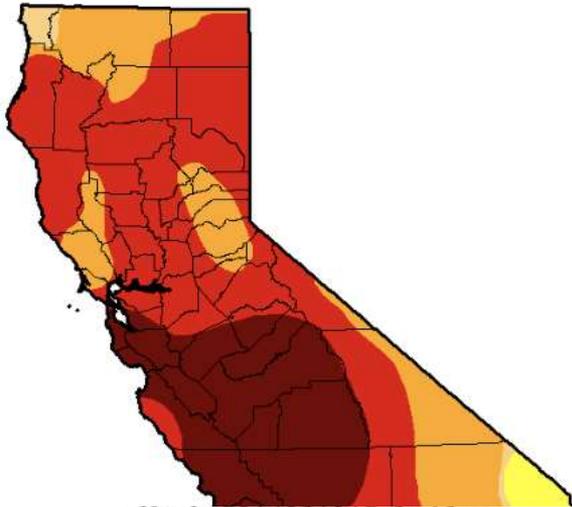
NWM



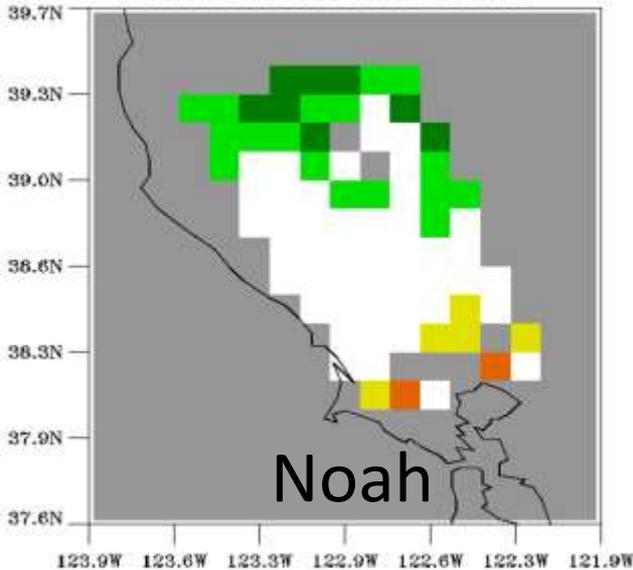
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Percentile

U.S. Drought Monitor California

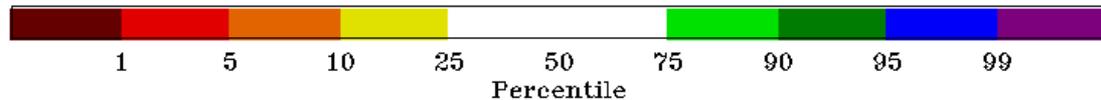
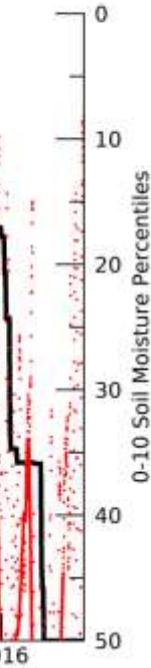
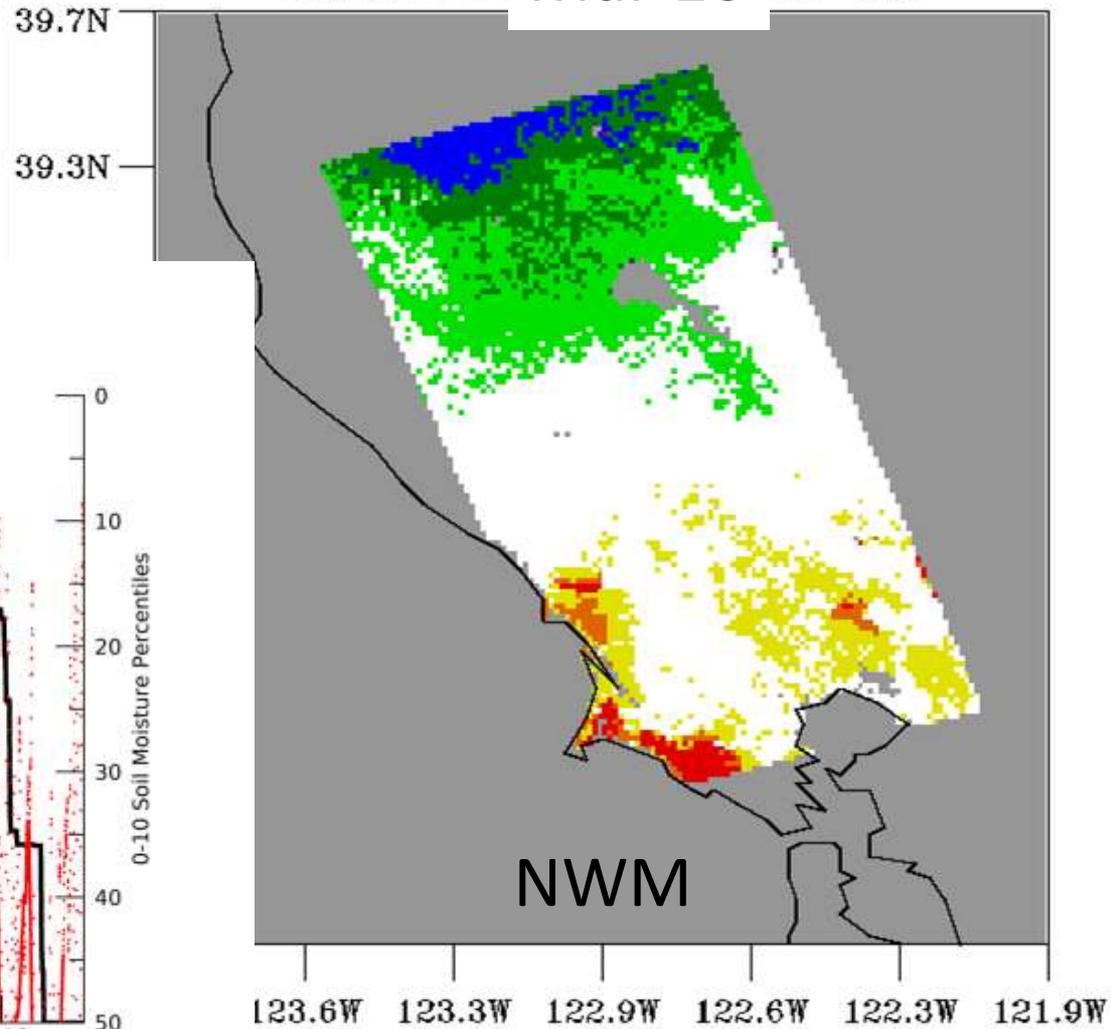


Noah 2014031012 0-10 cm

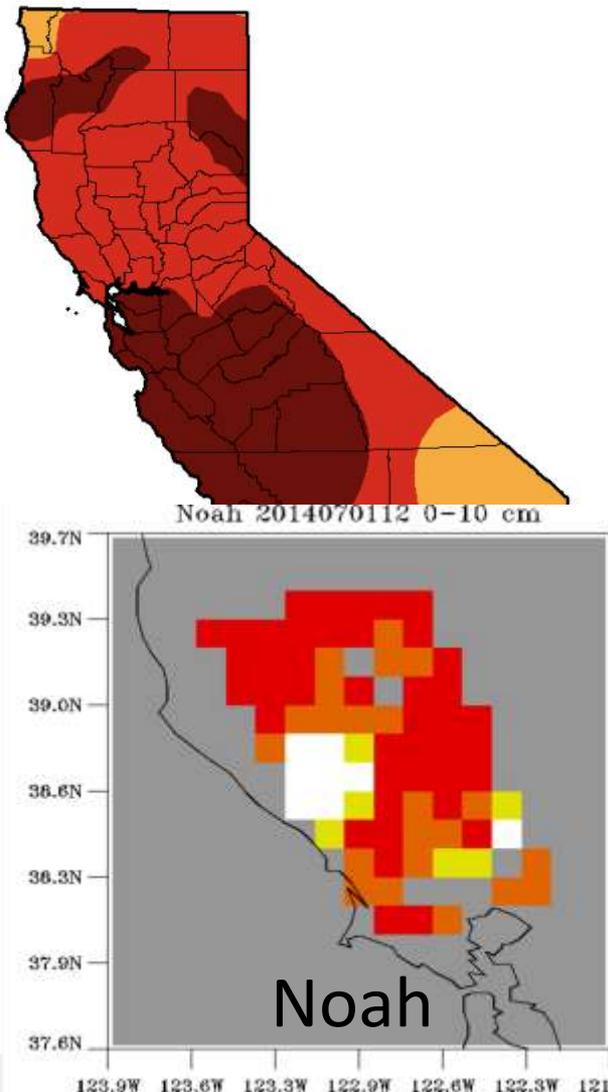


Noah

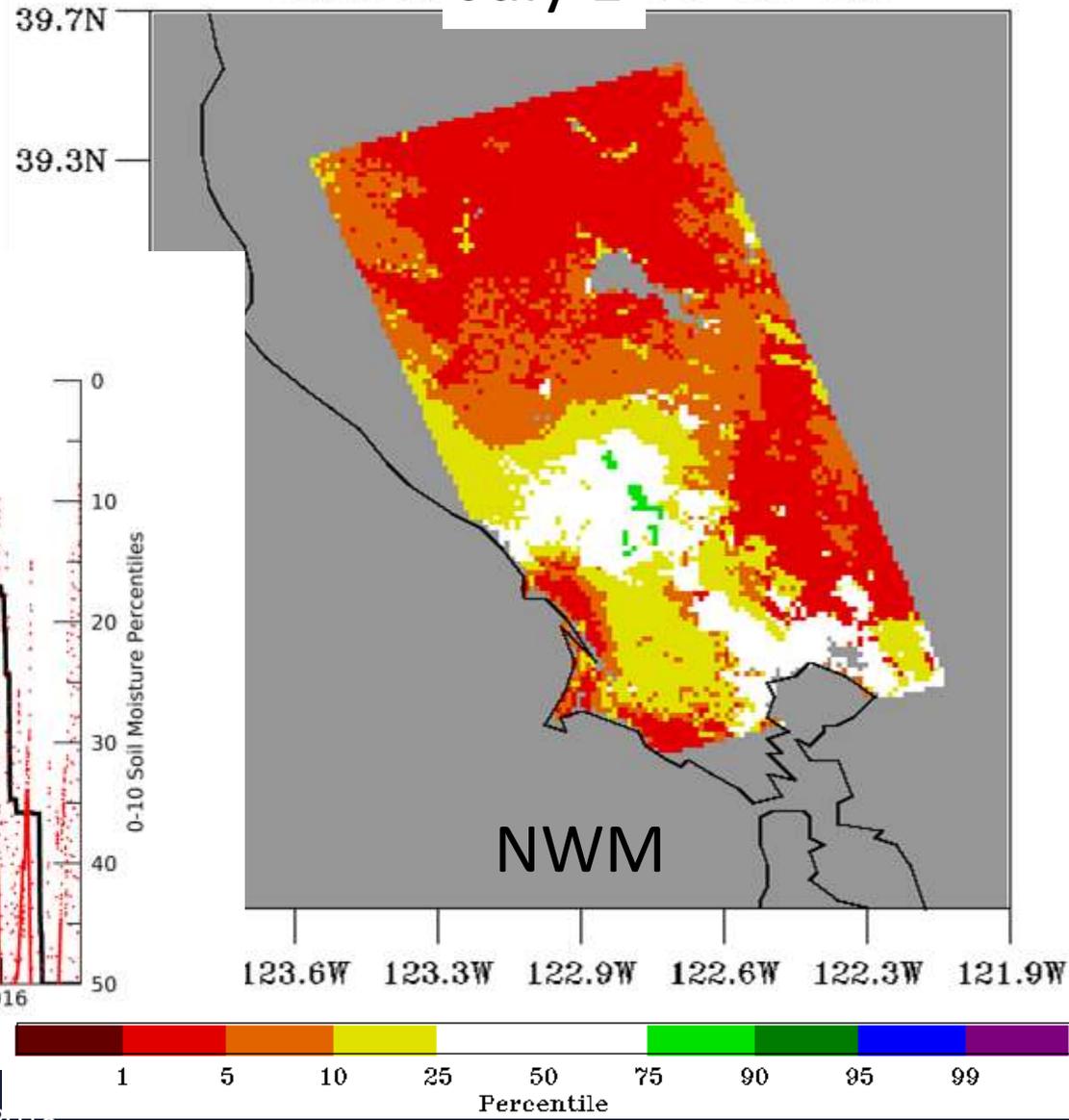
NWM 2014 Mar 10 10 cm



U.S. Drought Monitor California

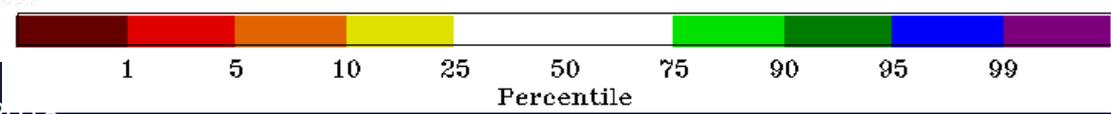
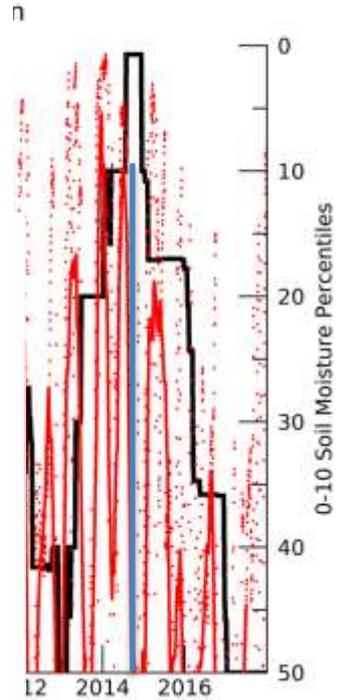
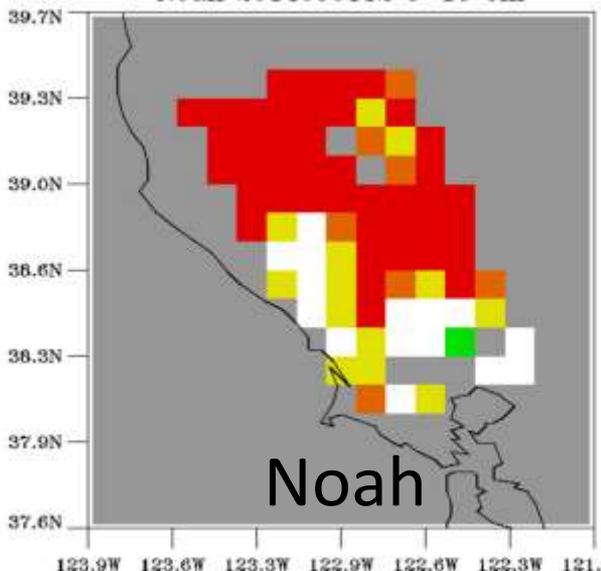
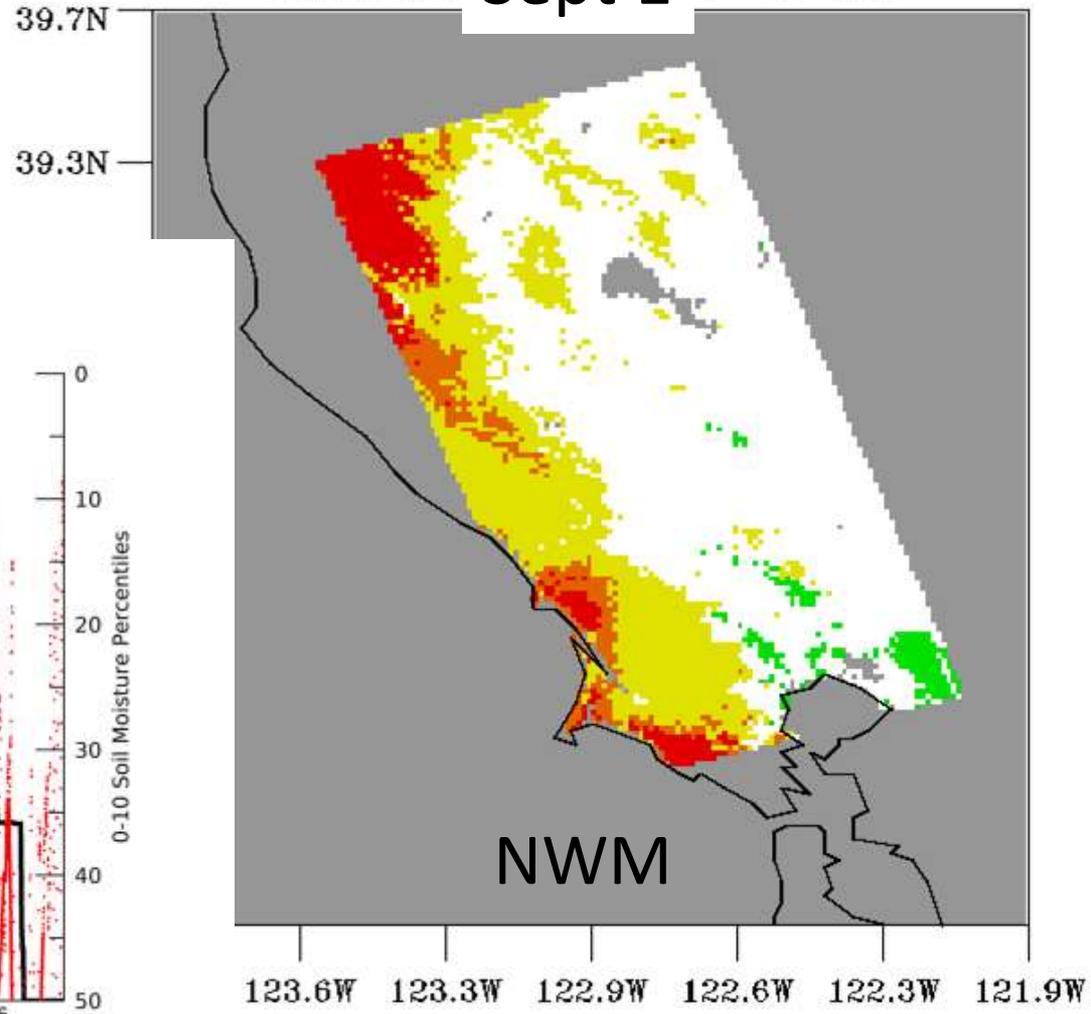
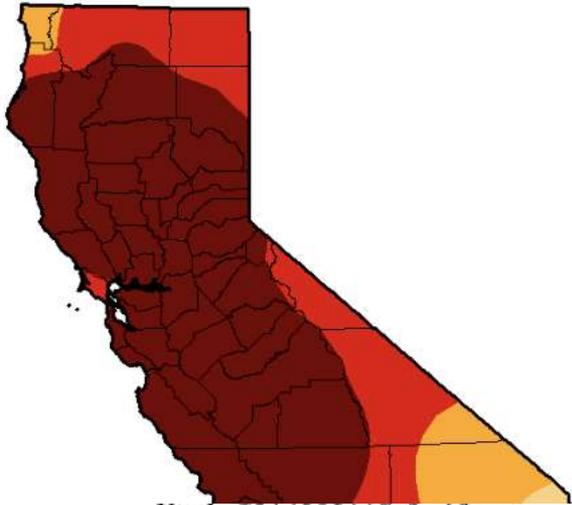


NWM 20 July 12 0-10 cm

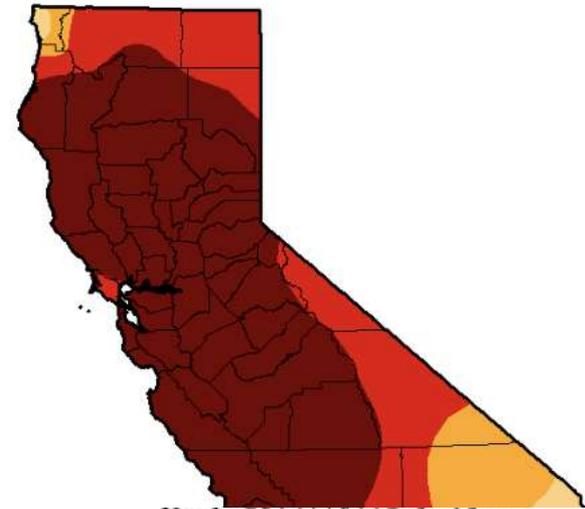


U.S. Drought Monitor California

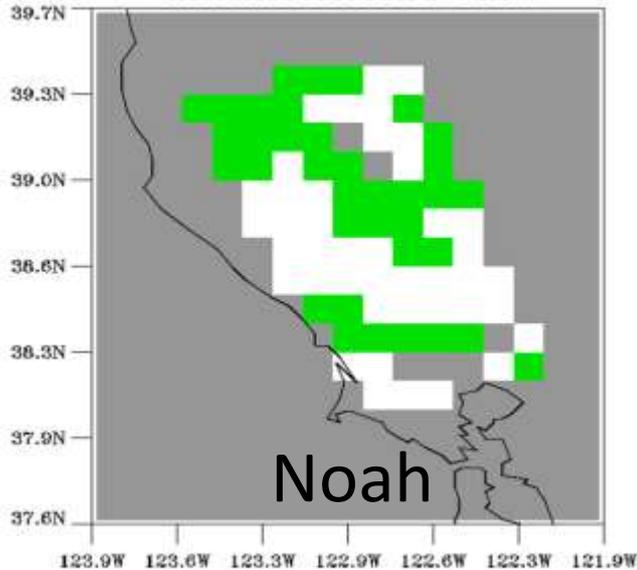
NWM 20 Sept 1 0-10 cm



U.S. Drought Monitor California

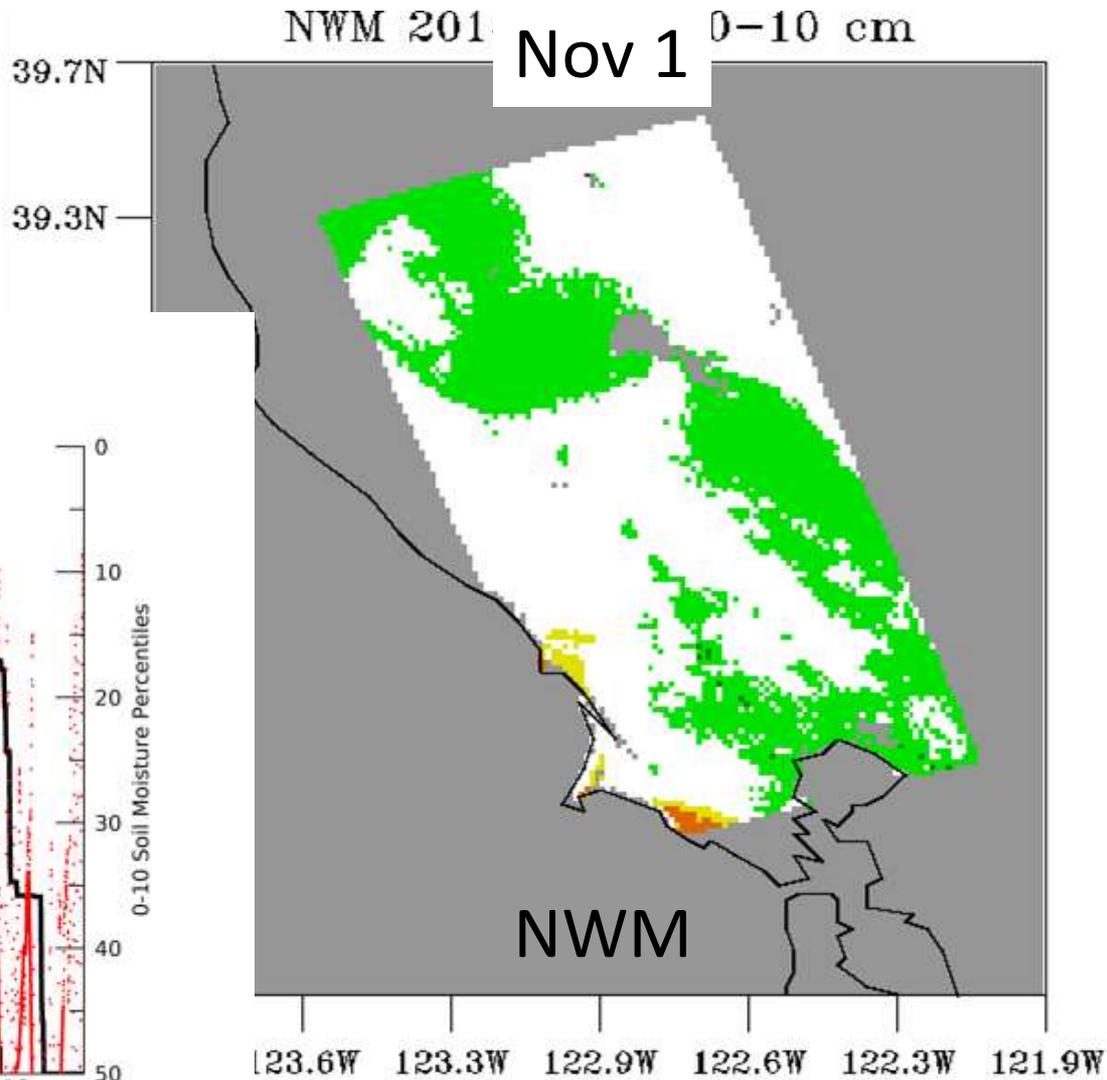


Noah 2014110112 0-10 cm



Noah

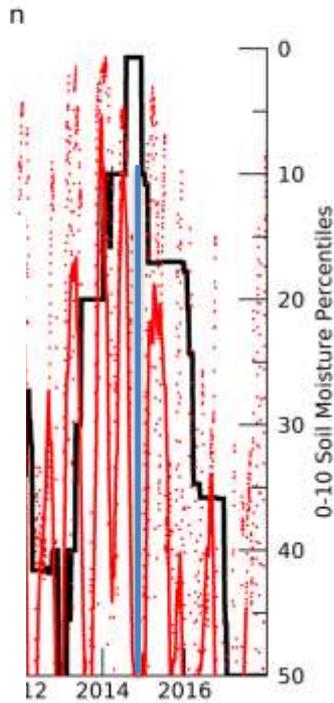
123.9W 123.6W 123.3W 122.9W 122.6W 122.3W 121.9W



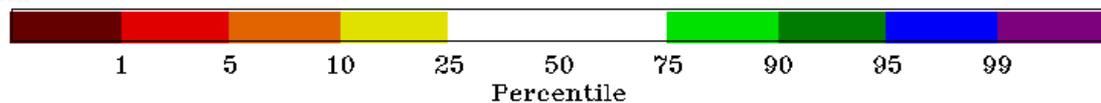
NWM 201 Nov 1 0-10 cm

NWM

123.6W 123.3W 122.9W 122.6W 122.3W 121.9W



0-10 Soil Moisture Percentiles



1 5 10 25 50 75 90 95 99

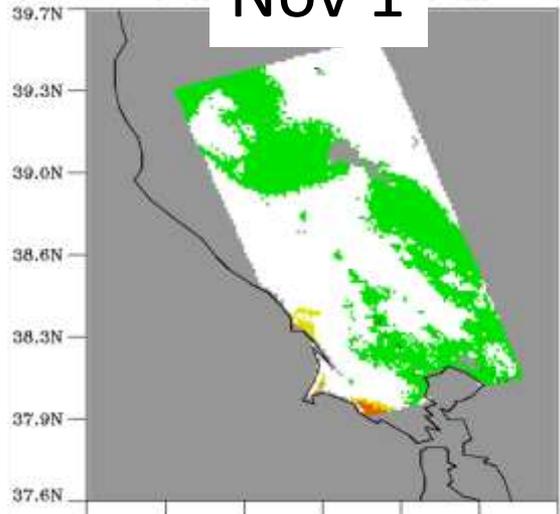
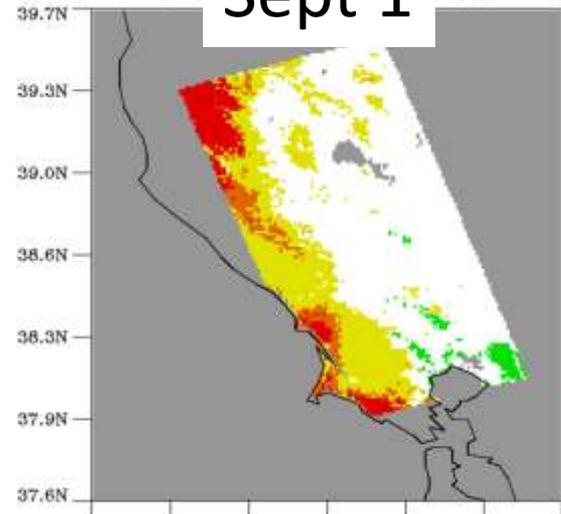
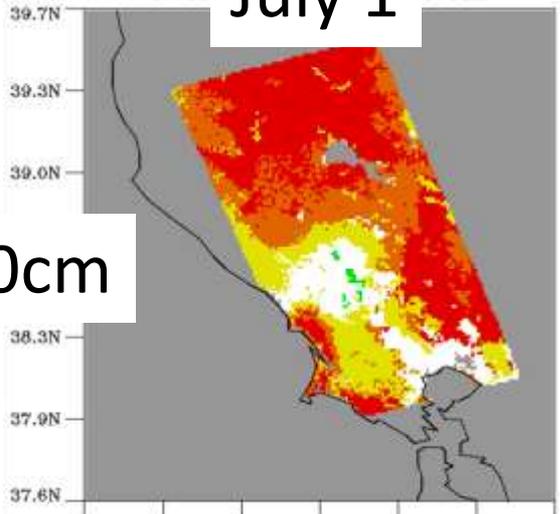
Percentile

0-10cm

July 1 0 cm

Sept 1 0 cm

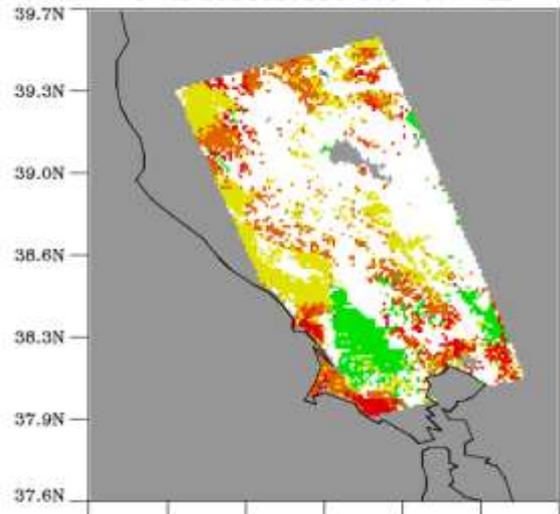
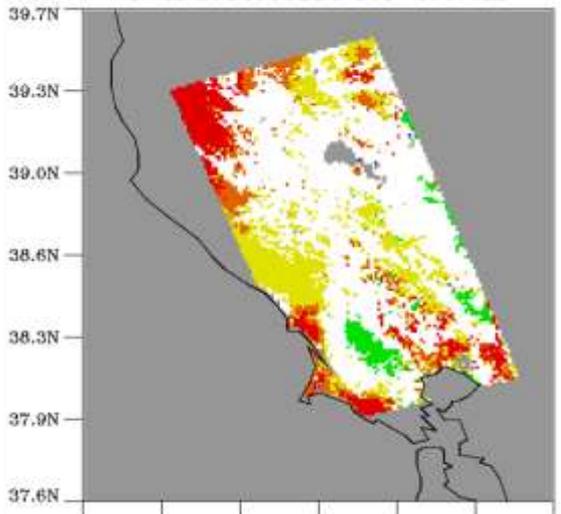
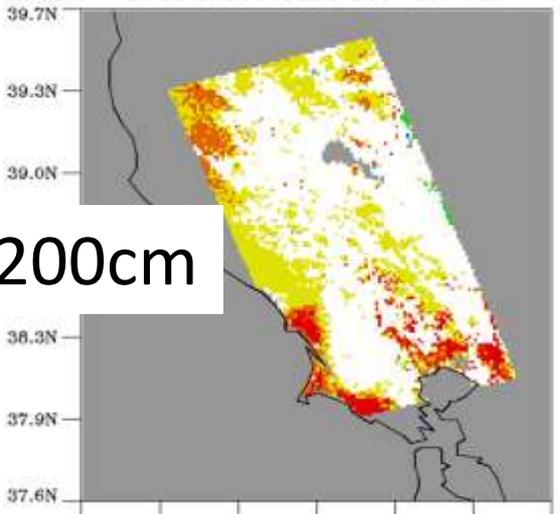
Nov 1 0 cm



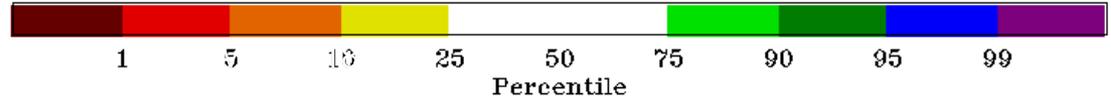
NWM 2014070112 100-200 cm

NWM 2014090112 100-200 cm

NWM 2014110112 100-200 cm

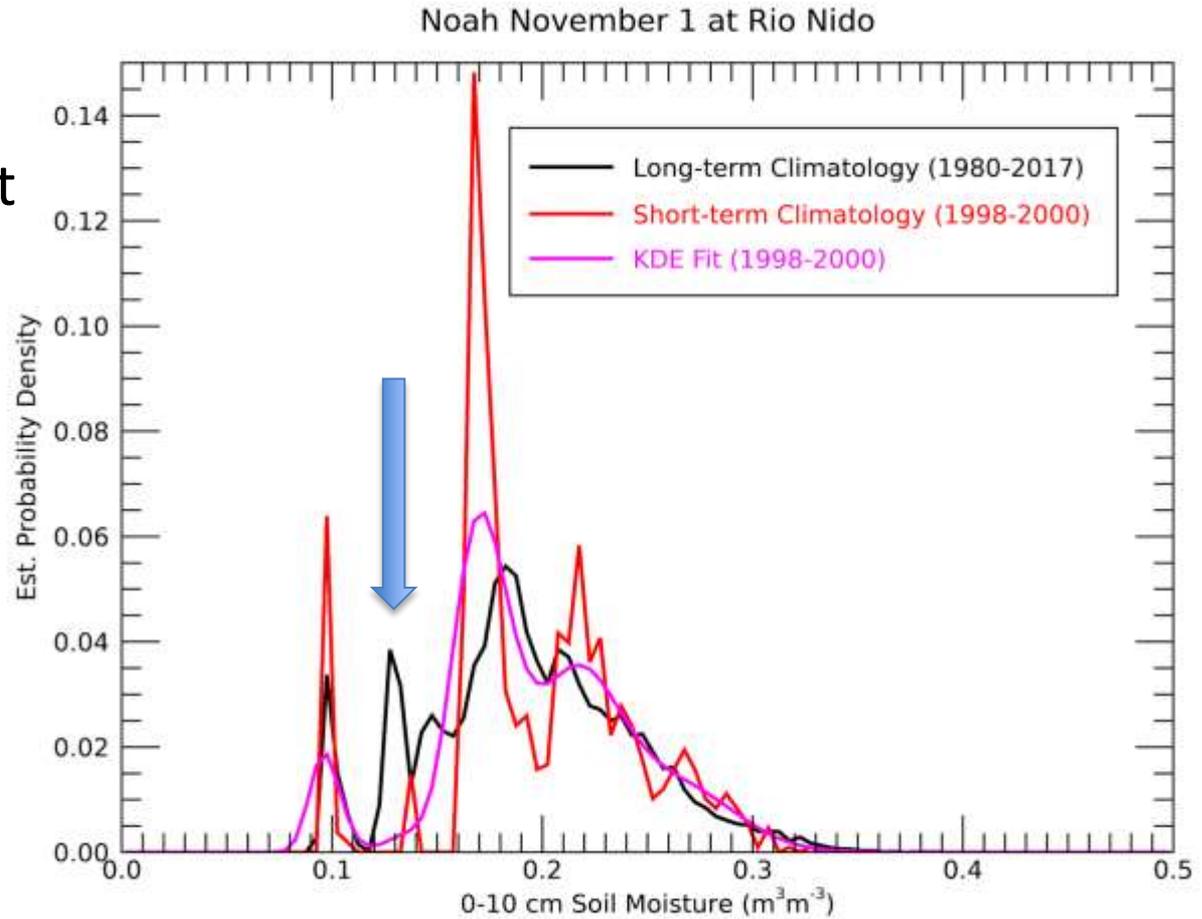


100-200cm



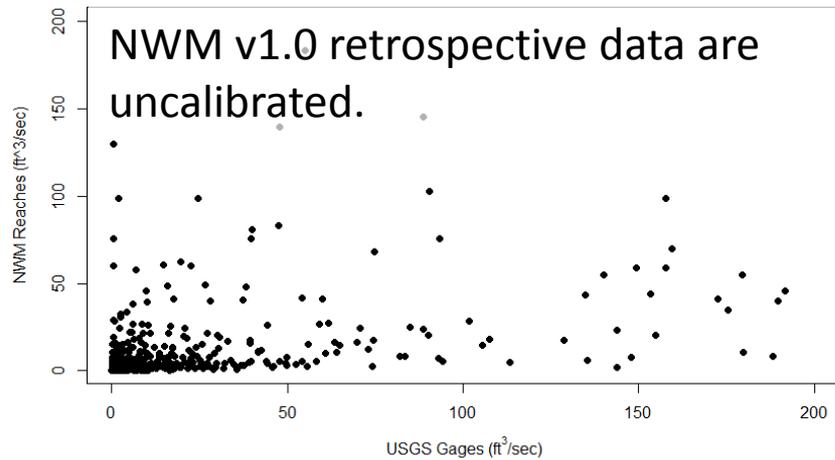
Estimation of reference climatology with KDE

- 0-10 cm layer soil moisture PDFs for both long and short term for one grid cell at Rio Nido in the Russian River Basin.
- Kernel Density Estimation (KDE) method used to fit short-term climatology.

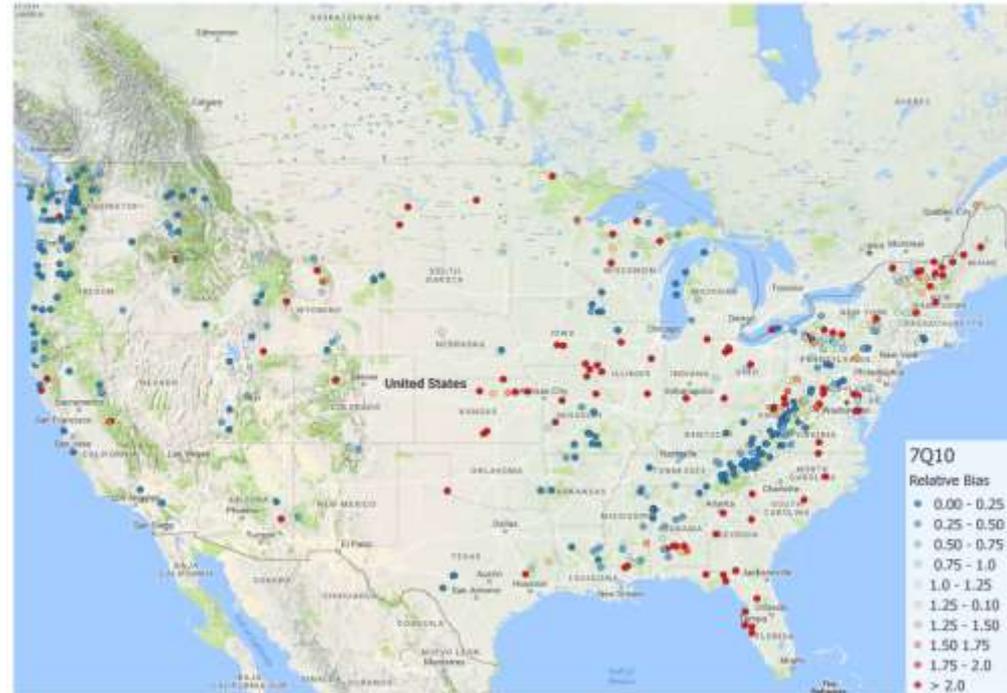
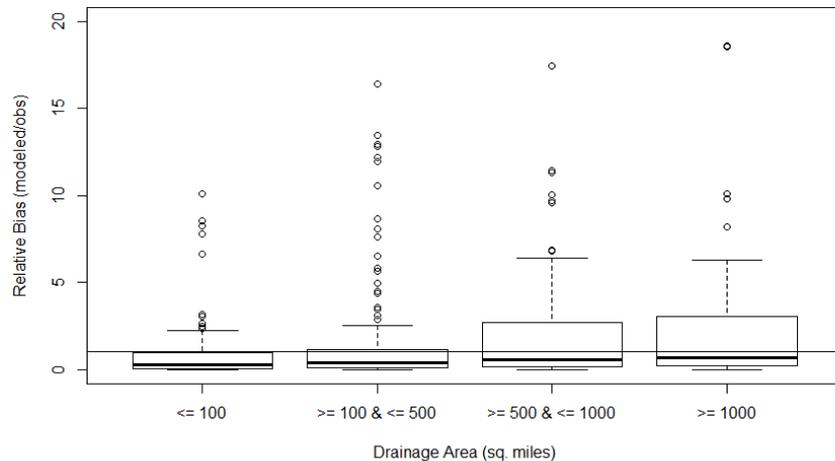


Lowflow (7Q10) Evaluation: NWM v1.0 Retrospective Data

7Q10: USGS Reference Gages vs NWM Reaches

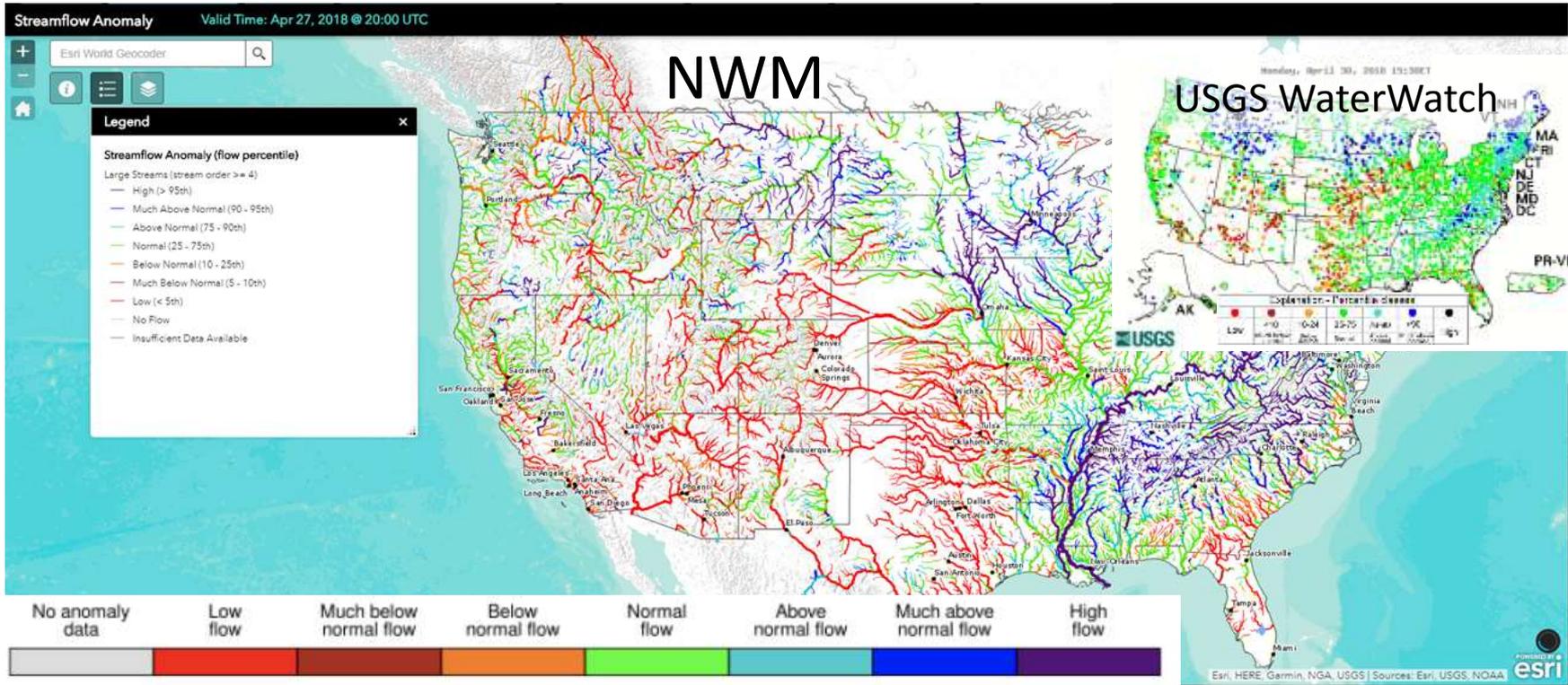


7Q10: NWM Relative Bias vs Drainage Area



Map of NWM relative bias using USGS reference gages where at least 90% of the data were available.

Future Work: NWM Streamflow Anomaly Percentiles for Drought Monitoring



<http://water.noaa.gov/tools/nwm-image-viewer>

Also developing other products similar to USGS WaterWatch (e.g., below-normal 28-day avg streamflow).



Thanks!

Would love to hear from you: What would you like to see? What products could be useful for the US and NA DM?

Email: mimi.hughes@noaa.gov

NWM: <http://water.noaa.gov/about/nwm>

The National Water Model Version 1: Technical Specs

Development Team: NCAR/RAL, NOAA/OWP/NWC, USGS, CUAHSI, Universities

Sponsor: NOAA Office of Water Prediction

Data Throughput:

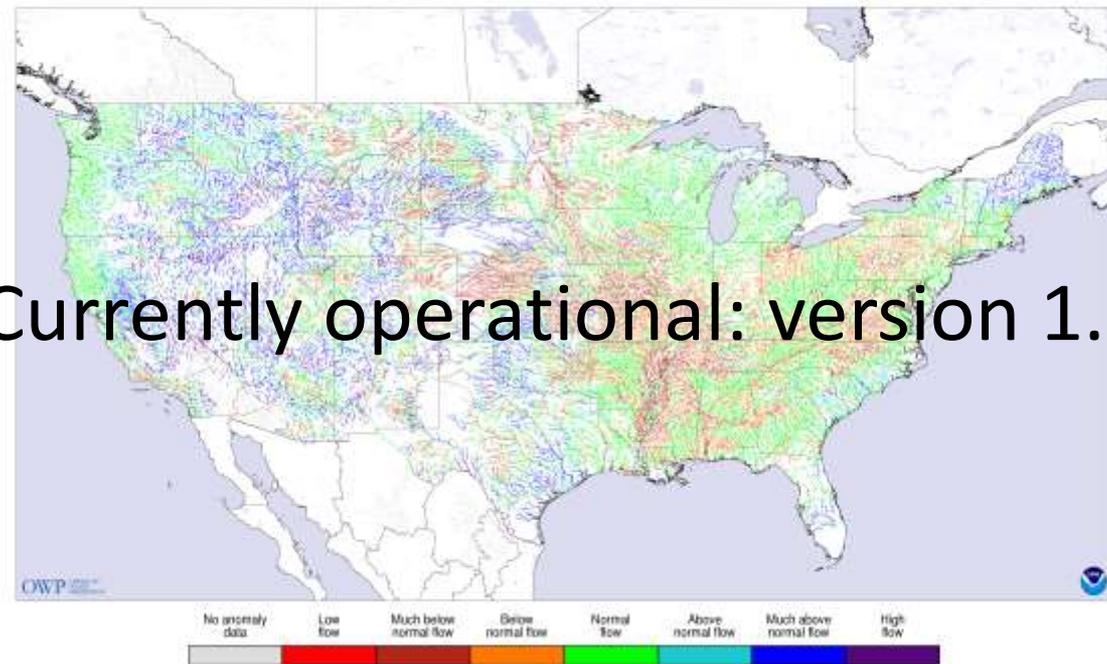
- Input data per day: 4.45 Terabytes
- Output data per day: 3 Terabytes
- # of river channels: 2.7 million
- # of reservoirs: 1,260
- Total # of computational elements: ~360,000,000

Model Details:

- Number of lines of code: 74,740
- Computer usage: > 100,000 cpu-hours per day

National Streamflow Anomaly Map

National Water Model Streamflow Anomaly Guidance
Analysis valid for 2017-04-19 11:00:00 UTC
Model initialized at 2017-04-19 08:00:00 UTC



Available online at: <http://water.noaa.gov/tools/nwm-image-viewer>